

Appendix H

Special Status Wildlife Species with Potential to Occur

This page left blank intentionally.

Appendix H
Special Status Wildlife Species with Potential to Occur

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Invertebrates						
Conservancy fairy shrimp <i>Branchinecta conservation</i>	E, X	--	Northern two-thirds of the Central Valley. It ranges from Vina Plains of Tehama County; Sacramento NWR in Glenn County; Jepson Prairie Preserve and surrounding area east of Travis Air Force Base, Solano County; Mapes Ranch west of Modesto, Stanislaus County.	Inhabits the ephemeral water of swales and vernal pools. It is most commonly found in grass or mud bottomed swales, earth sump, or basalt flow depression pools in unplowed grasslands.	Has been collected from early December to early May.	None. Occurrences have been documented within the Seller Service Area. Suitable habitat occurs within the project area. No impacts to vernal pool or other habitats occupied by this species are anticipated. The species is not likely to occur to occur in rice fields and canals due to predators (i.e. fish).
Longhorn fairy shrimp <i>Branchinecta longiantenna</i>	E, X	--	Restricted to northern, central, and portions of southern California; populations along the eastern margin of the Central Coast Mountains from Concord, Contra Costa County south to Soda Lake in San Luis Obispo County; the Kellogg Creek watershed; the Altamont Pass area; the western and northern boundaries of Soda Lake on the Carrizo Plain; and Kesterson National Wildlife Refuge in the Central Valley.	Found in ephemeral freshwater habitats, such as vernal pools and swales.	Has been observed from late December until late April	None. Occurrences have been documented within the Seller Service Area. Suitable habitat may occur within the project area. The species is not likely to occur to occur in rice fields and canals due to predators (i.e. fish). The project is not expected to impact any suitable grassland vernal pools or swales.
Mid-valley fairy shrimp <i>Branchinecta mesovallensis</i>	Under review	--	Counties within the Great Central Valley, including Sacramento, Solano, Merced, Madera, San Joaquin, Fresno, and Contra Costa Counties.	Found in vernal pools, seasonal wetlands that fill with water during fall and winter rains	Has been collected from early December to early May.	Suitable habitat may occur within the project area. Low potential for occurrence due to predators (i.e. fish).
Valley elderberry longhorn beetle <i>Desmocerus californicus dimorphus</i>	T, X	--	Central Valley and surrounding foothills below 3,000 feet elevation.	Dependent on elderberry shrubs (host plant) as a food source. Potential habitat is shrubs with stems 1 inch in diameter within Central Valley.	Year round for host plant and exit holes; March-June for adults	Elderberry shrubs would not be impacted, therefore no impact to beetles would occur.
Vernal pool fairy shrimp <i>Branchinecta lynchi</i>	T, X	--	Endemic to the Central Valley, Central Coast Mountains, and South Coast Mountains of California. It ranges from the Vina Plains in Tehama County, through the Central Valley, and south along the Central Coast to northern Santa Barbara County.	Inhabits the ephemeral water of swales and vernal pools. It is most commonly found in grassed or mud bottomed swales, earth sump, or basalt flow depression pools in unplowed grasslands.	Has been collected from early December to early May.	None. Occurrences have been documented in both the Buyer and the Seller Service areas. Rice fields and canals are not likely to support this species due to the presence of predators (i.e. fish), therefore no impacts are anticipated to the species. The project is not expected to impact vernal pools or natural wetlands.

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Vernal pool tadpole shrimp <i>Lepidurus packardii</i>	E, X	--	Endemic to the northern portion of the Central Valley of California. This species occurs from the Millville Plains and Stillwater Plains in Shasta County south throughout the Central Valley to Merced County.	Found in a variety of natural and artificial seasonally ponded habitat types including: vernal pools, swales, ephemeral drainages, stock ponds, reservoirs, ditches, backhoe pits, and ruts caused by vehicular activities.	Has been collected from early December to early May.	None. Occurrences have been documented in both the Buyer and the Seller Service area. Suitable habitat is present in the project area. Rice fields and canals are not likely to support this species due to the presence of predators (i.e. fish), therefore there is a low potential for impacts to the species. The project is not expected to impact vernal pools or natural wetlands. No impacts to the species are expected.
Amphibians						
California tiger salamander <i>Ambystoma californiense</i>	T ¹ , E ² , X	CE, SSC	Found in annual grassland habitat, grassy understories of valley-foothill hardwood habitats, and uncommonly along stream courses in valley-foothill riparian habitats. Occurs from near Petaluma, Sonoma Co., east through the Central Valley to Yolo and Sacramento Counties and south to Tulare Co.; and from the vicinity of San Francisco Bay south to Santa Barbara Co.	Lives in vacant or mammal-occupied burrows, occasionally other underground retreats, throughout most of the year, in grassland, savanna, or open woodland habitats. Lays eggs on submerged stems and leaves, usually in shallow ephemeral or semi permanent pools and ponds that fill during heavy winter rains, sometimes in permanent ponds; breeding takes place in fish free pools and ponds.	Migrates up to about 2 km between terrestrial habitat and breeding pond. Migrations may occur from November through April.	None. Occurrences have been documented within both the Buyer and Seller Service Areas. Suitable habitat may occur within the project area, but would not be impacted by the project. This species is not expected to occur in rice fields due to predatory fish.
Foothill yellow-legged frog <i>Rana boylei</i>	SC	SSC	This species is known from the Pacific drainages from Oregon to the upper San Gabriel River, Los Angeles County, California, including the coast ranges and Sierra Nevada foothills in the United States.	This species inhabits partially shaded, rocky streams at low to moderate elevations, in areas of chaparral, open woodland, and forest.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Areas. Suitable habitat is present within the project area. However the project is not expected to impact any suitable rocky stream and woodland habitats. No impact to the species is expected.
Western spadefoot toad <i>Spea hammondi</i>	--	SSC	This species occurs in the Central Valley and bordering foothills of California and along the Coast Ranges into northwestern Baja California, Mexico.	Lowlands to foothills, grasslands, open chaparral, pine-oak woodlands. Prefers shortgrass plains, sandy or gravelly soil. It is fossorial and breeds in temporary rain pools and slow-moving streams that do not contain bullfrogs, fish, or crayfish.	Year round. Usually in underground burrows most of year, but would travel several meters on rainy nights. Movement is rarely extensive.	None. Occurrences have been documented from both the Buyer and Seller Service Areas. Suitable habitat is present in the project area. The project would not impact suitable upland habitat types. The species is not likely to occur in rice fields due to the
Reptiles						

Appendix H
Special Status Wildlife Species with Potential to Occur

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Giant garter snake <i>Thamnophis gigas</i>	T	T	Sacramento and San Joaquin Valleys from Butte County in the north to Kern County in the south.	Primarily associated with marshes, sloughs, and irrigation ditches. Generally absent in larger rivers.	Year round	High. Suitable habitat is present within the Buyer and Seller Service Areas. Suitable habitat in the Seller Service Area is intermittent based on normal variation in cropping. Direct impacts may include reduction in suitable aquatic habitat within the Seller Service Area. The greatest impact would occur during the breeding season. Conservation measures are in place to maintain aquatic habitat corridors within irrigation ditches.
Western pond turtle <i>Actinemys marmorata</i>	Under review	SSC	Ranged from extreme western Washington and British Columbia to northern Baja California, mostly to the west of the Cascade-Sierra crest.	The western pond turtle occupies a wide variety of wetland habitats including rivers and streams (both permanent and intermittent), lakes, ponds, reservoirs, permanent and ephemeral shallow wetlands, abandoned gravel pits, stock ponds, and sewage treatment.	Year round	High. Suitable habitat occurs within the project area. Pond turtles may occur in ditches, canals, rice fields, etc.
Birds						
Aleutian Canada goose <i>Branta canadensis leucopareia</i>	D	--	Alaska to California	Found grazing in golf courses, agricultural lands, and any open ground adjacent to water. Nests in grasses and marshes.	Year round	Suitable habitat is present in project area. Low impact would occur. Can relocate to other habitats within the area.
American peregrine falcon <i>Falco peregrinus anatum</i>	D, NMBMC	E, FP	Throughout California.	Breeds in woodland, forest and coastal habitats on protected cliffs and ledges. Riparian areas and coastal and inland wetlands are important habitats yearlong especially during the non-breeding season.	Year round	None. Rice fields may provide suitable foraging habitat for the species, but birds could relocate to other habitat areas in the vicinity. No nesting habitat would be affected by the project.
Bald eagle <i>Haliaeetus leucocephalus</i>	D	E	Throughout California.	Riparian areas near coasts, rivers, and lakes. Nesting generally occurs in large old-growth trees in areas with little disturbance.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Area and both areas provide suitable habitat. No impacts to suitable nesting habitat are anticipated. Rice fields represent marginal foraging habitat. Birds would be able to relocate to other suitable habitat areas in the vicinity if fields were fallowed.

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Bank swallow <i>Riparia riparia</i>	--	T, SSC	A neotropical migrant found primarily in riparian and other lowland habitats in California west of the deserts during the spring-fall period. Breeding population in California occurs along banks of the Sacramento and Feather rivers in the northern Central Valley.	Requires vertical banks and cliffs with fine-textured or sandy soils near streams, rivers, ponds, lakes, and the ocean for nesting. Feeds primarily over grassland, shrub land, savannah, and open riparian areas during breeding season and over grassland, brushland, wetlands, and cropland during migration.	March-mid-September	None. Known from both the Buyer and Seller Service Areas. No suitable nesting habitat (i.e. cliffs) would be affected. There is potential that the project would reduce the area of cropland habitat used for foraging during migration (wetlands and croplands) due to changes in water application. However, fallow cropland would still providing suitable foraging habitat, and birds could forage at other croplands in the vicinity.
Black tern <i>Chlidonias niger</i>	--	SSC	Common spring and summer visitor to fresh emergent wetlands of California.	Uses fresh emergent wetlands, lakes, ponds, moist grasslands, and agricultural fields. In migration, some take coastal routes and forage offshore.	April-September	Suitable habitat is present within the project area (i.e. rice fields) and a high potential to occur. Conservation strategies are in place for this species. High. No occurrences have been documented within either the Buyer or Seller Service Areas. However, suitable habitat (i.e. rice fields) is present, and the project area is within the known range for the species. Therefore it has moderate potential to occur. Water transfers could reduce suitable habitat for the species within the Seller Service Area. Conservation strategies are in place that would make potential impacts to this species to negligible.
Black-crowned night heron <i>Nycticorax nycticorax</i>	SC	--	Resident in lowlands and foothills throughout most of California, including the Salton Sea and Colorado River areas, and very common locally in large nesting colonies.	Feeds along the margins of lacustrine, large riverine, and fresh and saline emergent habitats. Nests and roosts in dense-foliaged trees and dense emergent wetlands.	Year round	None. No occurrences of black-crowned night heron have been documented within either the Buyer or Seller Service Areas. Suitable habitat is present in project area, however no nesting or roosting habitats would be affected.
California yellow warbler <i>Dendroica petechia brewsteri</i>	--	SSC	Throughout California	Frequents open to medium-density woodlands and forests with a heavy brush understory in breeding season. In migration, found in a variety of sparse to dense woodland and forest habitats.	April-October	None. No occurrences have been documented in the project area. The species is not likely to occur in rice fields, and no suitable habitat would be impacted (i.e. dense woodland and forest habitats).

Appendix H
Special Status Wildlife Species with Potential to Occur

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Cooper's hawk <i>Accipiter cooperii</i>	--	WL	Throughout California	Frequents landscapes where wooded areas occur in patches and groves. Often uses patchy woodlands and edges with snags for perching. Dense stands with moderate crown-depths used for nesting.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Area. Suitable habitat occurs within the project area. No potential impacts to preferred foraging or nesting habitat are anticipated.
Double-crested cormorant <i>Phalacrocorax pelagicus</i>	--	WL	Along the entire coast of California and on inland lakes, in fresh, salt and estuarine waters.	Open water with offshore rocks, islands, steep cliffs, dead branches of trees, wharfs, jetties, or even transmission lines. Requires undisturbed nest-sites beside water, on islands or mainland. Uses wide rock ledges on cliffs; rugged slopes; and live or dead trees, especially tall ones.	Year round	None. No occurrences have been documented within the project area, but the species could occur at reservoirs and inland ponds. No negative impacts to foraging or breeding habitat are expected.
Golden eagle <i>Aquila chrysaetos</i>	T	E	Throughout California	Riparian areas near coasts, rivers, and lakes. Nesting generally occurs in large old-growth trees in areas with little disturbance.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Areas. Suitable habitat occurs within the project area. No impacts to nesting habitat are expected.
Great blue heron <i>Ardea herodias</i>	--	--	Throughout California	Found in shallow estuaries, fresh and saline emergent wetlands, along riverine and rocky marine shores, in croplands, pastures, salt ponds, and in mountains above foothills. Nests roosts in large trees.	Year round	None. Rookeries have been documented within the Buyer and Seller Service Areas. No impacts to rookeries are anticipated. Birds could use alternative suitable foraging areas in the vicinity.
Great egret <i>Ardea alba</i>	--	--	Throughout California	Feeds and rests in fresh, and saline emergent wetlands, along the margins of estuaries, lakes, and slow-moving streams, on mudflats and salt ponds, and in irrigated croplands and pastures. Nests roosts in large trees.	Year round	None. Occurrences have been documented in the Seller Service Area. No impacts to rookeries are anticipated. Birds could use alternative suitable foraging areas in the vicinity.
Greater sandhill crane <i>Grus canadensis tabida</i>	--	T, FP	Breeds only in Siskiyou, Modoc and Lassen counties and in Sierra Valley, Plumas and Sierra counties. Winters primarily in the Sacramento and San Joaquin valleys from Tehama south to Kings Counties.	In summer, this race occurs in and near wet meadow, shallow lacustrine, and fresh emergent wetland habitats. Frequents annual and perennial grassland habitats, moist croplands with rice or corn stubble, and open, emergent wetlands. It prefers relatively treeless plains.	Migration southward is September-October and northward is March-April.	High. No occurrences have been documented within the project area, but occurrences have been recorded in Butte and Sutter Counties. Suitable foraging and winter roosting habitat is present within the project area (i.e. rice fields). Conservation strategies are in place for this species and birds would have other suitable nesting sites available.

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Little willow flycatcher <i>Empidonax traillii brewsteri</i>	--	E	Migrant at lower elevations, primarily in riparian habitats throughout California	Most numerous where extensive thickets of low, dense willows edge on wet meadows, ponds, or backwaters.	Spring (mid-May to early June) and fall (mid-August to early September)	None. This species has not been documented within the project area according to CNDDDB. Suitable habitat may be present within the project area (i.e. dense willows), but would not be impacted by the project.
Long-billed curlew <i>Numenius americanus</i>	SC	WL	Along the California coast, and in the Central and Imperial valleys.	Upland shortgrass prairies and wet meadows are used for nesting; coastal estuaries, open grasslands, and croplands are used in winter.	Winter migrant from July-April	Low. No CNDDDB occurrences have been documented within the project area, but the species is known to occur within the action area during winter migration. There is potential for impacts to suitable foraging habitat (i.e. cropland), although this may be reduced by environmental commitments, which protect winter foraging habitat in Butte Sink, and other wildlife management areas downstream. Birds can relocate to other suitable habitats within the area.
Long-eared owl <i>Asio otus</i>	--	SSC	Throughout California	Frequents dense, riparian and live oak thickets near meadow edges, and nearby woodland and forest habitats. Also found in dense conifer stands at higher elevations.	Year round	None. Occurrences have been documented in the Buyer Service Area. Suitable habitat occurs within the project area. The project is not expected to impact any suitable habitat (i.e. forest and woodland habitats).
Osprey <i>Pandion haliaetus</i>	--	WL	Northern California from Cascade Ranges south to Lake Tahoe, and along the coast south to Marin County.	Associated strictly with large, fish-bearing waters, primarily in ponderosa pine through mixed conifer habitats.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Area. Suitable habitat occurs within the project area. Water transfers would be subject to flow requirements. Therefore no impacts to foraging area expected. No impacts to nesting sites are anticipated.
Short-eared owl <i>Asio flammeus</i>	--	SSC	Endemic to marshes bordering the San Francisco, San Pablo Bays and Suisun Bay .	Open country, including grasslands, wet meadows and cleared forests. Occasionally in estuaries during breeding season.	Year round	None. Occurrences have been documented in the Buyer Service Area. Suitable habitat occurs within the project area. No impacts to breeding habitat would occur. Fallow rice fields would still represent suitable foraging habitat for the species.

Appendix H
Special Status Wildlife Species with Potential to Occur

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Snowy egret <i>Egretta thula</i>	--	--	Throughout California	Found along shores of coastal estuaries, fresh and saline emergent wetlands, ponds, slow-moving rivers, irrigation ditches, and wet fields.	Year round	None. Occurrences have been documented in the Buyer Service Area, however suitable habitat is present in both the Buyer and Seller Service area. No impacts to rookeries are anticipated. Idling of cropland foraging habitat would be limited by the environmental commitments, and birds could use alternative suitable foraging areas in the vicinity.
Swainson's hawk <i>Buteo swainsoni</i>	SC, MNBMC	T	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley.	Nests in mature trees, including valley oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, and grain and row crop fields.	Spring and Summer; small wintering population in the Delta	None. CNDDDB occurrences have been documented within both the Seller and Buyer Service Area. Suitable habitat is present within the project area. The project may alter the composition of foraging habitat in the Buyer and Seller Service Areas, but these areas would still be suitable for the species, and additional habitats in the vicinity would be available. No impacts to breeding habitat are expected.
Tricolored blackbird <i>Agelaius tricolor</i>	--	SSC	A resident in California found throughout the Central Valley and in coastal districts from Sonoma Co. south.	Breeds near fresh water, preferably in emergent wetlands with tall, dense cattails or tules, but also in thickets of willow, blackberry, wild rose, tall herbs. Feeds in grassland and cropland habitats.	Year round	Low. CNDDDB occurrences have been documented within both the Seller and Buyer Service Area. Suitable habitat is present within the project area. Foraging habitat may be affected by the project. Environmental commitments limit cropland idling and birds can relocate to other adjacent foraging habitats within the area.
Western burrowing owl <i>Athene cucularia hypugaea</i>	--	SSC	Central and southern coastal habitats, Central Valley, Great Basin, and deserts.	Open annual grasslands or perennial grasslands, deserts, and scrublands characterized by low-growing vegetation. Dependent upon burrowing mammals (especially California ground squirrel) for burrows.	Year round	None. Occurrences have been documented within both the Buyer and Seller Service Area. Suitable habitat occurs within the project area. Agricultural ditches may be suitable habitat for burrowing owl burrow and nesting activity. Water transfers would not affect the suitability of habitat for burrowing owl in the project area.

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Western snowy plover <i>Charadrius alexandrinus</i>	T	SSC	Along the west coast states, with inland nesting taking place at the Salton Sea, Mono Lake, and at isolated sites on the shores of alkali lakes in northeastern California, in the Central Valley, and southeastern deserts.	Nests, feeds, and takes cover on sandy or gravelly beaches along the coast, on estuarine salt ponds, alkali lakes, and at the Salton Sea.	Migration is from July to March (some year round populations).	None. Occurrences have been documented in the Buyer Service Area. There is a CNDDDB occurrence in Yolo County, however this species is not likely to occur in rice fields. Suitable habitat may occur within the project area. However the project is not expected to impact any suitable breeding or foraging habitat (i.e. sandy beaches or estuarine salt ponds).
Western yellow-billed cuckoo <i>Coccyzus americanus</i>	SC, C	E	Uncommon to rare summer resident in scattered locations throughout California.	Deciduous riparian thickets or forests with dense, low-level or understory foliage, and which abut on slow-moving watercourses, backwaters, or seeps. Willow almost always a dominant component of the vegetation. In Sacramento Valley, also utilizes adjacent orchards, especially of walnut. Nests in sites with some willows, dense low-level or understory foliage, high humidity, and wooded foraging spaces.	Summer migration is from June-September.	None. Occurrences have been documented in the Seller Service Area. Suitable habitat is present within the project area. However this species is not likely to occur in rice fields due to lack of suitable foraging and roosting habitat (i.e. dense riparian thickets). No impacts are anticipated.
White-faced ibis <i>Plegadis chihi</i>	--	WL	Uncommon summer resident in sections of southern California, a rare visitor in the Central Valley, and is more widespread in migration.	Feeds in fresh emergent wetlands, shallow lacustrine waters, muddy grounds of wet meadows, and irrigated or flooded pastures and croplands. Nests in dense, fresh emergent wetlands.	Present in California from April-October.	Low. Occurrences have been documented in the Seller Service Area. Suitable habitat is present in project area. Low potential impact to foraging habitat in the Seller Service Area. No potential impacts are expected to roosting habitat. Can relocate to other habitats within the area. Environmental commitments would limit acreage of allowable cropland idling.
White-tailed kite <i>Elanus leucurus</i>	SC, MNBMC	FP	Central Valley, coastal valleys, San Francisco Bay area, and low foothills of Sierra Nevada.	Savanna, open woodlands, marshes, partially cleared lands and cultivated fields, mostly in lowland situations (Tropical to Temperate zones).	Year round	None. CNDDDB occurrences have been documented within both the Seller and Buyer Service Area. Suitable habitat is present within the project area. Foraging habitat may be altered, but would still be suitable for the species. No potential impacts to breeding habitat are anticipated.

Appendix H
Special Status Wildlife Species with Potential to Occur

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				
Mammals						
California wolverine <i>Gulo gulo</i>	SC	T, FP	A scarce resident of North Coast mountains and Sierra Nevada. Sightings range from Del Norte and Trinity cos. east through Siskiyou and Shasta cos., and south through Tulare Co. A few possible sightings occur in the north coastal region as far south as Lake Co. Habitat distribution in California is poorly known for the North Coast and northern Sierra Nevada.	In north coastal areas, has been observed in Douglas-fir and mixed conifer habitats. In the northern Sierra Nevada, have been found in mixed conifer, red fir, and lodgepole habitats, and probably use subalpine conifer, alpine dwarf-shrub, wet meadow, and montane riparian habitats. In the southern Sierra Nevada occur in red fir, mixed conifer, lodgepole, subalpine conifer, alpine dwarf-shrub, barren, and probably wet meadows, montane chaparral, and Jeffrey pine.	Year round (largely nocturnal)	None. Suitable habitat may occur within the project area, however no CNDDDB occurrences have been documented in the Buyer or Seller Service area. The species is not likely to occur in agriculture fields. No impacts are anticipated.
Greater western mastiff bat <i>Eumops perotis californicus</i>	SC	SSC	Uncommon resident in southeastern San Joaquin Valley and Coastal Ranges from Monterey Co. southward through southern California, from the coast eastward to the Colorado Desert.	Occurs in many open, semi-arid to arid habitats, including conifer and deciduous woodlands, coastal scrub, annual and perennial grasslands, palm oases, chaparral, desert scrub, and urban areas. Crevices in cliff faces, high buildings, trees, and tunnels are required for roosting.	Year round (nocturnal activity)	None. Occurrences have been documented in the Seller Service Area. Suitable habitat is present in project area, but no impacts are anticipated.
Ring-tailed cat <i>Brassariscus astutus</i>	SC	FP	Ringtails are found in a variety of habitats centered around the semi-arid to arid climates of the west and southwest. Little information available on distribution and relative abundance among habitats.	Occurs in various riparian habitats, and in brush stands of most forest and shrub habitats, at low to middle elevations. Uses hollow trees, logs, snags, cavities in talus and other rocky areas, and other recesses are for cover.	Year round (nocturnal)	None. No CNDDDB records of this species have been documented in the project area. Suitable habitat is present in project area, but the species is not likely to occur in rice fields. No potential impact to suitable habitat are expected.

¹Central CA DPS

²Santa Barbara and Sonoma Counties

Green Shading: potential to be affected, further evaluated in Chapter 3

* Status explanations:

Federal

E = listed as endangered under the federal Endangered Species Act

T = listed as threatened under the federal Endangered Species Act

MNBMC = Fish and Wildlife Service: Migratory Nongame Birds of Management Concern

SC = species of concern; formerly Category 2 candidate for federal listing

C = Candidate for listing as threatened or endangered

-- = no designations

X = critical habitat

PX = potential critical habitat

D = delisted

State

E = listed as endangered under the California Endangered Species Act

2014 Tehama-Colusa Canal Authority Water Transfers
 Environmental Assessment/Initial Study

Common Name <i>Scientific Name</i>	Special Status*		Distribution	Habitat Association	Seasonal Occurrence	Potential Impact
	Federal	State				

T = listed as threatened under the California Endangered Species Act
 CE = candidate endangered under the California Endangered Species Act
 FP = fully protected under the California Fish and Game Code
 SSC = species of special concern
 WL = Watch List
 -- = no designations

Appendix I

Special Status Plant Species with Potential to Occur

This page left blank intentionally.

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Ahart's dwarf rush <i>Juncus leiospermus</i> var. <i>ahartii</i>	-/- 1B	Butte, Calaveras, Placer, Sacramento, Tehama, and Yuba Counties.	Valley and foothill grassland (mesic).	March-May	Not likely to occur in rice fields, no suitable habitat present.
Ahart's paronychia <i>Paronychia ahartii</i>	-/- 1B	Butte, Shasta, and Tehama Counties.	Cismontane woodland, valley and foothill grassland, and vernal pools.	March-June	Not likely to occur in rice fields, no suitable habitat present.
Alkali milk-vetch <i>Astragalus tener</i> var. <i>tener</i>	-/- 1B	Central western California including Yolo County.	Subalkaline flats and areas around vernal pools.	March-June	Not likely to occur in rice fields, no suitable habitat present (i.e. subalkali flats).
Antioch Dunes evening-primrose <i>Oenothera deltooides</i> ssp. <i>howellii</i>	E/E/ 1B	Found only in Contra Costa and Sacramento Counties.	Occurs in inland dunes.	March-September	Not likely to occur in rice fields, no suitable habitat present. Located outside of the project area.
Brittlescale <i>Atriplex depressa</i>	-/-1B	Western Central Valley and valleys of adjacent foothills.	Alkali grassland, alkali meadow, alkali scrub, and vernal pools.	April-October	There is a CNDDDB occurrence within Glenn, Colusa, and Yolo counties, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. alkali and vernal pools).
Boggs Lake hedge-hyssop <i>Gratiola hetersepela</i>	-/-1B	Dispersed throughout the Sacramento and Central Valley. Also in Oregon.	Marsh's, swamps, and vernal pools (clay).	April-August	There is a CNDDDB occurrence within Sacramento County. Suitable habitat is present but has low potential to occur.
Butte County meadowfoam <i>Limnanthes floccosa</i> ssp. <i>californica</i>	E/E/1B	Only located in Butte County.	Valley and foothill grassland (mesic), and vernal pools.	March-May	Not likely to occur in rice fields, no suitable habitat present.

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Contra Costa goldfields <i>Lasthenia conjugens</i>	E/SSC/1B	San Francisco Bay Delta Regions, and scattered coastal areas.	Cismontane woodlands, playas, valley and foothill grasslands, and vernal pools.	March-June	No CNDDDB occurrences; not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools, playas).
Colusa grass <i>Neostapfia colusana</i>	T/E/1B	Southern Sacramento Valley, and northern San Joaquin Valley.	Vernal pools.	May-July	There is a CNDDDB occurrence within Glenn and Colusa counties, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).
Crampton's tuctoria (Solano grass) <i>Tuctoria mucronata</i>	E/E/1B	Located only in Yolo and Solano Counties.	Valley and foothill grassland (mesic), and vernal pools.	April-August	Not likely to occur in rice fields, no suitable habitat present.
Ferris' milk-vetch <i>Astragalus tener</i> var. <i>ferrisae</i>	-/-/1B	Sacramento Valley.	Subalkaline flats and areas around vernal pools.	March-June	Not likely to occur in rice fields, no suitable habitat present.
Fox sedge <i>Carex vulpinoidea</i>	-/-/2	Northern Sacramento Valley, including Butte County, isolated populations in San Joaquin County.	Riparian woodland, marshes and swamps.	May-June	Suitable habitat present in project area. Low potential to occur. Not likely to establish in rice fields.
Greene's tuctoria <i>Tuctoria greenii</i>	E/SSC/1B	Butte, Colusa, Fresno, Glenn, Madera, Merced, Modoc, Shasta, San Joaquin, Stanislaus, Tehama, and Tulare Counties.	Vernal pools.	May-July	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Hairy Orcutt grass <i>Orcuttia pilosa</i>	E/E/1B	Northern Sacramento Valley, Pit River Valley; isolated populations in Lake and Sacramento counties.	Vernal pools.	May-September	There is a CNDDDB occurrence within Butte and Glenn counties, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).
Hartweg's golden sunburst <i>Pseudobahia bahiifolia</i>	E/E/1B	Found in El Dorado, Fresno, Madera, Merced, Stanislaus, Tuolumne, and Yuba Counties.	Cismontane woodland, valley and foothill grassland, often acidic.	April-May	There is a CNDDDB occurrence within Yolo County, however this species is not likely to occur in rice fields due to lack of suitable habitat
Heartscale <i>Atriplex cordulata</i>	-/-/1B	Western Central Valley and valleys of adjacent foothills.	Alkali grasslands, alkali meadows, and alkali scrub.	May-October	There is a CNDDDB occurrence within Butte, Colusa, Yolo, and Glenn counties, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. alkali areas).
Heckard's pepper-grass <i>Lepidium latipes</i> var. <i>heckardii</i>	-/-/1B	Glenn, Solano, and Yolo Counties.	Valley and foothill grassland alkaline flats.	March-May	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. alkali flats).
Henderson's bent grass <i>Agrostis hendersonii</i>	-/-/ 3	Found in Butte, Calaveras, Merced, Placer, Shasta, and Tehama counties. Also found in Oregon.	Vernal pools.	March- June	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Hoover's spurge <i>Chamaesyce hooveri</i>	T/-/ 1B	Scattered in Glenn, Butte, Colusa, Merced, Stanislaus, Tehama, and Tulare Counties.	Vernal pools.	July-September	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).
Indian valley brodiaea <i>Brodiaea coronaria</i> <i>ssp. rosea</i>	-E/1B	Scattered in Glenn, Lake, Colusa, and Tehama Counties.	Closed cone coniferous forest, chaparral, valley and foothill grasslands (serpentinite).	May-June	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat.
Jepson's milk-vetch <i>Astragalus rattanii</i> <i>var. jepsonianus</i>	-/-/1B	Colusa, Glenn, Lake, Napa, Tehama, and Yolo counties.	Chaparral, cismontane woodland, valley and foothill grassland, often serpentinite.	April-June	There is a CNDDDB occurrence, however this species is not likely to occur on the site due to lack of suitable habitat.
Keck's checkerbloom <i>Sidalcea keckii</i>	E/-/1B	Colusa, Fresno, Merced, Napa, Solano, Tulare, and Yolo counties.	Cismontane woodlands, foothill and valley grasslands (serpentinite).	April-May	There is a CNDDDB occurrence, however this species is not likely to occur on the site due to lack of suitable habitat.
Legenere <i>Legenere limosa</i>	SC/-/1B	Sacramento Valley and south of the North Coast Ranges.	Vernal pools.	May-June	Not likely to occur in rice fields, no suitable habitat present (i.e. vernal pools)
Lesser saltscale <i>Atriplex minuscula</i>	-/-/1B	Found in Butte, Fresno, Kern, Madera, Merced, Stanislaus, and Tulare Counties.	Chenopod scrub, playas, valley and foothill grasslands (alkali and sandy).	May-October	Not likely to occur in rice fields, no suitable habitat present (i.e. alkali, sandy)

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Lone buckwheat <i>Eriogonum apricum</i> var. <i>apricum</i>	E/E/1B	Found in Amador and Sacramento Counties.	Chaparral.	July-October	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (chaparral).
Marsh checkerbloom <i>Sidalcea oregana</i> ssp. <i>hydrophila</i>	-/-/1B	Glenn, Lake, Mendocino, and Napa Counties.	Meadows and seeps, and riparian forest.	June-August	Suitable habitat present in project area. Low potential to occur. Not likely to establish in rice fields.
Milo Baker's lupine <i>Lupinus milo-bakeri</i>	-/T/1B	Glenn and Mendocino Counties.	Cismontane woodlands, foothill and valley grasslands.	June-September	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat.
Palmate-bracted bird's-beak <i>Cordylanthus palmatus</i>	E/E/1B	Found in Glenn and Colusa Counties and within the Central Valley.	Alkali meadow, alkali scrub, valley and grasslands.	May-October	Not likely to occur in rice fields, no suitable habitat present (i.e. alkali).
Pincushion navarretia <i>Navarretia myersii</i> ssp. <i>myersii</i>	-/-/1B	Alamador, Calaveras, Merced, Placer, and Sacramento Counties.	Vernal pools (often acidic).	May	No CNDDDB occurrences; not likely to occur due to lack of suitable habitat (i.e. vernal pools).
Recurved larkspur <i>Delphinium recurvatum</i>	-/-/1B	Disbursed throughout the Sacramento and Central Valley.	Chenopod scrub, cismontane, valley and foothill grasslands (alkali).	March-June	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. alkali).

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Red mountain catchfly <i>Silene campanulata</i> <i>ssp. campanulata</i>	-/E/1B	Found in Colusa, Glenn, Mendocino, Shasta, Tehama, and Trinity Counties.	Chaparral and lower montane coniferous forest, usually sepeptinite and rocky.	April-July	There is a CNDDDB occurrence in Colusa County, however this species is not likely to occur in rice fields due to lack of suitable habitat.
Rose-mallow <i>Hibiscus laiocarpus</i>	-/-/2	Northern Sacramento County.	Marshes and swamps.	June-September	Suitable habitat present in project area. Low potential to occur. Not likely to establish in rice fields.
Sacramento orcutt grass <i>Orcuttia viscida</i>	E/E/1B	Valley grasslands and freshwater wetlands.	Vernal pools.	May-June	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).
San Joaquin spearscale <i>Atriplex joaquiniana</i>	-/-/1B	Western Central Valley and valleys of adjacent foothills.	Alkali grasslands, and alkali scrub.	April-September	Not likely to occur in rice fields, no suitable habitat present (i.e. alkali).
Sanford's arrowhead <i>Sagittaria sanfordii</i>	-/-/1B	Central Valley.	Freshwater marshes, shallow streams, and ditches.	May-August	Suitable habitat on present in ditches; not yet detected. Not likely to establish in rice fields.

Common Name <i>Scientific name</i>	Special Status* (F/S/CNPS)	Distribution	Habitat Association	Blooming Period	Potential Impact
Silky cryptantha <i>Cryptantha crinita</i>	-/-/1B	Shasta and Tehama Counties.	Cismontane woodland, lower montane coniferous forest, riparian forest and woodland, valley foothill and grasslands.	April-May	Not likely to occur in rice fields, no suitable habitat present. Located outside of the project area.
Slender Orcutt grass <i>Orcuttia tenuis</i>	T/E/1B	Northern Sacramento Valley, Pit River Valley; isolated populations in Lake and Sacramento Counties	Vernal pools.	May-July	There is a CNDDDB occurrence, however this species is not likely to occur in rice fields due to lack of suitable habitat (i.e. vernal pools).
Soft bird's beak <i>Cordylanthus mollis</i> ssp. <i>mollis</i>	E/SSC/1B	Located in Contra Costa, Marin, Napa, Sacramento, Solano, and Sonoma Counties.	Coastal salt marshes and swamps.	July-November	There is a CNDDDB occurrence in Sacramento County, however this species is not likely to occur in rice fields due to lack of suitable habitat.

***Status explanations:**

F=Federal

E=Endangered

T=Threatened

SC= Special Concern

S=State

E=Endangered

T=Threatened

SSC=Species of Special Concern

CNPS=California Native Plant Society

1B=Rare, threatened, or endangered in California and elsewhere

2=Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere

3=Plants about which we need more information - A review list

This page left blank intentionally.

Appendix J

Greenhouse Gas Emission Calculations

This page left blank intentionally.

Summary of Annual Greenhouse Gas Emissions

Table 1. GHG Emissions from Groundwater Substitution

Water Agency	Emissions (MTCO ₂ e/year)			
	CO ₂	CH ₄	N ₂ O	Total
Anderson-Cottonwood Irrigation District	134	0.21	0.65	135
Canal Farms	20	0.03	0.10	20
Conaway Preservation Group	1,319	1.59	4.91	1,325
Eastside Mutual Water Company	352	0.30	0.88	353
Glenn-Colusa Irrigation District	175	0.27	0.85	176
Glenn-Colusa Irrigation District (to Westside WD)	3,761	3.42	10.19	3,775
Maxwell Irrigation District	827	0.70	2.08	830
Natomas Central Mutual Water Company	620	0.88	2.76	624
Pelger Mutual Water Company	293	0.30	0.90	295
Pleasant Grove-Verona Mutual Water Company	1,250	1.24	3.72	1,255
Princeton-Codora-Glenn Irrigation District	618	0.54	1.60	621
Provident Irrigation District	672	0.60	1.77	674
Reclamation District 108	575	0.89	2.80	578
Reclamation District 1004	482	0.44	1.33	483
River Garden Farms	192	0.30	0.93	193
Roberts Ditch Irrigation District	59	0.09	0.29	59
Sycamore Mutual Water Company	231	0.36	1.13	233
T&P Farms	19	0.03	0.09	19
Te Velde Revocable Family Trust	79	0.12	0.38	79
Total	11,677	12.30	37.36	11,727

Table 2. Summary of Project Greenhouse Gas Emissions

Emission Source	Annual Emissions (MTCO ₂ e/year)			
	CO ₂	CH ₄	N ₂ O	Total
Groundwater Substitution	11,677	12	37	11,727
Crop Idling	(3,364)	(3)	(10)	(3,378)
Total (metric tons/year)	8,313	9	27	8,349
Total (short tons/year)	9,163	10	30	9,203

1 short ton = 0.9072 metric tons

Groundwater Substitution GHG Emissions

Agency Anderson-Cottonwood Irrigation District
 Transfer Volume 4,800 acre feet/year
 Location Shasta County

Table 3. Anderson-Cottonwood Irrigation District GHG Emissions

Description	Well	Fuel Type	Power Rating (hp)	Pump Rate			Transfer Volume (acre feet/year)	Operation			Fuel Consumption (gal/yr)	GHG Emissions						
				(AF)	(gpm)	(% of Total)		(hours/year)	(kWh/yr)	(tonnes per year)			(MTCO2e per year)					
										CO2		CH4	N2O	CO2	CH4	N2O	Total	
	Barney Street	Electric	200	4,350	5,500	83%	3,996	3,946	588,945	n/a	105	0.0077	0.0016	105	0.16	0.51	106	
	Crowley Gulch	Electric	50	875	1,000	17%	804	4,365	162,891	n/a	29	0.0021	0.0005	29	0.04	0.14	29	
				Total		100%	4,800	8,311	751,835	0	134	0.0099	0.0021	134	0.21	0.65	135	

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Canal Farms
Transfer Volume 860 acre feet/year
Location Colusa County

Table 4. Canal Farms GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation (hours/year)	(kWh/yr)	Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)					(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
Dennis Well North	Dennis Well North	E	0	110	3,500	50%	430	667	54,772	n/a	10	0.0007	0.0002	10	0.02	0.05	10
Dennis Well South	Dennis Well South	E	0	110	3,500	50%	430	667	54,772	n/a	10	0.0007	0.0002	10	0.02	0.05	10
				Total	7,000	100%	860	1,334	109,543	0	20	0.0014	0.0003	20	0.03	0.10	20

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr *(Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)*
 0.855 g/mL *(Based on MSDS for Hess Diesel Fuel All Types)*
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Conaway Preservation Group
Transfer Volume 26,639 acre feet/year
Location Yolo County

Table 5. Conaway Preservation Group GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation			Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)	(tonnes per year)			(MTCO2e per year)					
										CO2		CH4	N2O	CO2	CH4	N2O	Total	
Conaway PG6W-3	6W-3	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG5W-3	5W-3	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG7W-4	7W-4	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG12W-5	12W-5	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG1W-3	1W-3	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG12W-1	12W-1	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG7W-2	7W-2	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG13W-3	13W-3	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG7W-5	7W-5	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG32NW-2	32NW-2	Electric	TBD	114	3,500	4%	1,062	1,648	140,182	n/a	25	0.0018	0.0004	25	0.04	0.12	25	
Conaway PG33NW-4	33NW-4	Electric		100	3,400	4%	1,032	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PGOW-2	OW-2	Electric		100	3,400	4%	1,032	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PGOW-3	OW-3	Electric		125	3,400	4%	1,032	1,648	153,708	n/a	27	0.0020	0.0004	27	0.04	0.13	28	
Conaway PG32NW-1	32NW-1	Electric		100	3,300	4%	1,001	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG6-2	6-2	Electric		100	2,700	3%	819	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PGOW-1	OW-1	Electric		100	2,600	3%	789	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG20-1	20-1	Electric		100	2,500	3%	759	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG21W-1	21W-1	Electric		100	2,500	3%	759	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG31W-1	31W-1	Electric		100	2,300	3%	698	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG33NW-1	33NW-1	Electric		100	2,300	3%	698	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG8-1	8-1	Diesel	2007	170	2,300	3%	698	1,648	n/a	15,715	160	0.0065	0.0013	160	0.14	0.40	161	
Conaway PG33NW-2	33NW-2	Electric		100	2,200	3%	667	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG33NW-8	33NW-8	Electric		100	2,200	3%	667	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG33NW-3	33NW-3	Electric		100	2,100	2%	637	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG33NW-6	33NW-6	Electric		100	2,100	2%	637	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PGOW-5	OW-5	Electric		125	2,000	2%	607	1,648	153,708	n/a	27	0.0020	0.0004	27	0.04	0.13	28	
Conaway PG33NW-5	33NW-5	Electric		100	1,800	2%	546	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG7W-1	7W-1	Electric		100	1,800	2%	546	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG17W-3	17W-3	Diesel	2005	170	1,700	2%	516	1,648	n/a	15,715	160	0.0065	0.0013	160	0.14	0.40	161	
Conaway PGOW-4	OW-4	Electric		100	1,700	2%	516	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
Conaway PG16W-2	16W-2	Diesel	2005	170	1,600	2%	485	1,648	n/a	15,715	160	0.0065	0.0013	160	0.14	0.40	161	
Conaway PG8-2	8-2	Diesel	2002	170	1,500	2%	455	1,648	n/a	15,715	160	0.0065	0.0013	160	0.14	0.40	161	
Conaway PG33NW-7	33NW-7	Electric		100	1,400	2%	425	1,648	122,966	n/a	22	0.0016	0.0003	22	0.03	0.11	22	
					Total	100%	26,639	54,376	3,799,661	62,859	1,319	0.0759	0.0158	1,319	1.59	4.91	1,325	

Legend
Average HP from all pumps

Conversion Factors
1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwmnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption
0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential
CO2 1
CH4 21
N2O 310

Groundwater Substitution GHG Emissions

Agency Eastside Mutual Water Company
 Transfer Volume 2,000 acre feet/year
 Location Colusa County

Table 6. Eastside Mutual Water Company GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
Eastside MWC7631T	7631T	Diesel	2006	215	3,800	100%	2,000	2,858	n/a	34,476	352	0.014	0.003	352	0.30	0.88	353

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
 0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Glenn-Colusa Irrigation District
Transfer Volume 7,500 acre feet/year
Location Glenn County
 Colusa County

Table 7. Glenn-Colusa Irrigation District GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
GCID 1	GCID 1	Electric		100	3,000	19%	1,452	2,628	196,107	n/a	35	0.003	0.001	35	0.05	0.17	35
GCID 2	GCID 2	Electric		100	3,000	19%	1,452	2,628	196,107	n/a	35	0.003	0.001	35	0.05	0.17	35
GCID 3	GCID 3	Electric		100	3,000	19%	1,452	2,628	196,107	n/a	35	0.003	0.001	35	0.05	0.17	35
GCID 4	GCID 4	Electric		100	3,000	19%	1,452	2,628	196,107	n/a	35	0.003	0.001	35	0.05	0.17	35
Jacinto	Jacinto	Electric		100	3,500	23%	1,694	2,628	196,107	n/a	35	0.003	0.001	35	0.05	0.17	35
					Total	100%	7,500	13,139	980,534	0	175	0.013	0.003	175	0.27	0.85	176

Note: All wells are electric; therefore, no local criteria pollutant emissions.

Legend

Horsepower equal to data provided in GCID priority spreadsheet (2010PrirtyWells.xls) for Well
 Horsepower assumed to be equal to engine with known HP

Conversion Factors

1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr *(Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)*
0.855 g/mL *(Based on MSDS for Hess Diesel Fuel All Types)*
7.13 lb/gal

Global Warming Potential

CO2 1
CH4 21
N2O 310

Groundwater Substitution GHG Emissions

Agency Glenn-Colusa Irrigation District
Transfer Volume 18,668 acre feet/year
Location Glenn County
Colusa County

Table 8. Glenn-Colusa Irrigation District (Transfer to Westside WD) Criteria Pollutant Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (AF/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
RW-1	RW-1	E	2014	15	425	1%	280	3,579	40,058	n/a	7	0.001	0.0001	7	0.01	0.03	7
RW-2	RW-2	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
RW-3	RW-3	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
RW-4	RW-4	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
LW-1	LW-1	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
LW-2	LW-2	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
LW-3	LW-3	E	2014	30	850	3%	560	3,579	80,116	n/a	14	0.001	0.0002	14	0.02	0.07	14
TPHW-1	TPHW-1	D	2011	200	2,250	8%	1,483	3,579	n/a	40,152	410	0.017	0.0033	410	0.35	1.03	411
M&R	M&R	D	2014	350	3,200	11%	2,544	4,317	n/a	84,760	865	0.035	0.0070	865	0.74	2.18	868
SB&L#2	SB&L#2	D	2001	165	3,000	10%	1,194	2,161	n/a	20,004	204	0.008	0.0017	204	0.17	0.51	205
SB&L#3	SB&L#3	E	2014	70	500	2%	129	1,401	73,193	n/a	13	0.001	0.0002	13	0.02	0.06	13
SB&L#4	SB&L#4	E	2014	80	2,500	9%	664	1,442	86,103	n/a	15	0.001	0.0002	15	0.02	0.07	15
Vann#1	Vann#1	D	2013	260	3,000	10%	1,764	3,193	n/a	46,574	476	0.019	0.0039	476	0.40	1.20	477
Vann#2	Vann#2	D	2013	300	4,000	14%	2,744	3,725	n/a	62,691	640	0.026	0.0052	640	0.55	1.61	642
Vann#3	Vann#3	D	2013	300	3,000	10%	2,744	4,967	n/a	83,588	853	0.035	0.0069	853	0.73	2.15	856
Vann#4	Vann#4	E	2013	300	2,000	7%	1,764	4,789	1,072,269	n/a	191	0.014	0.0030	191	0.30	0.93	192
					28,975	100%	18,668	54,623	1,752,321	337,769	3,761	0.163	0.0329	3,761	3.42	10.19	3,775

Notes:
If a specific HP and emission tier combination has an emission standard of NMHC+NOx, then 95% of emissions assumed to be NOx and 5% of emissions assumed to be VOC (see CARB Carl Moyer Program Guidelines).
AP-42 emission factors used for SOx in all cases.
If an emission standard is not available for a given pollutant, then AP-42 emission factors used.
PM2.5 assumed to be 98% of PM10 emissions based on size fractions for stationary internal combustion diesel engines.

Legend
Data modified to meet transfer capacity

Conversion Factors
1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption
0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential
CO2 1
CH4 21
N2O 310

Groundwater Substitution GHG Emissions

Agency Maxwell Irrigation District
Transfer Volume 4,700 acre feet/year
Location Colusa County

Table 9. Maxwell Irrigation District GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
MID1	MID1	Diesel	2006	215	3,800	20%	940	1,343	n/a	16,204	165	0.007	0.001	165	0.14	0.42	166
MID2	MID2	Diesel	2006	215	3,800	20%	940	1,343	n/a	16,204	165	0.007	0.001	165	0.14	0.42	166
MID3	MID3	Diesel	2006	215	3,800	20%	940	1,343	n/a	16,204	165	0.007	0.001	165	0.14	0.42	166
MID4	MID4	Diesel	2006	215	3,800	20%	940	1,343	n/a	16,204	165	0.007	0.001	165	0.14	0.42	166
MID5	MID5	Diesel	2006	215	3,800	20%	940	1,343	n/a	16,204	165	0.007	0.001	165	0.14	0.42	166
				Total	100%		4,700	6,717	0	81,020	827	0.034	0.007	827	0.70	2.08	830

Legend

Engine information assumed to be equivalent to Eastside MWC because it is the adjacent water district.

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
 0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Natomas Central Mutual Water Company
Transfer Volume 30,000 acre feet/year
Location Sacramento County
Sutter County

Table 10. Natomas Central Mutual Water Company GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
	1	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	2	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	3	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	4	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	5	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	6	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	7	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	8	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	9	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	10	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	11	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	12	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
	13	Electric		110	4,200	8%	2,308	2,984	244,954	n/a	48	0.003	0.001	48	0.07	0.21	48
					Total	100%	30,000	38,792	3,184,400	0	620	0.042	0.009	620	0.88	2.76	624

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

- 1 lb = 453.6 g
- 1 tonne = 1,000 kg
- 1 tonne = 1,000,000 g
- 1 MWh = 1,000 kWh
- 1 GWh = 1,000,000 kWh
- 1 kW = 1.34 hp
- 1 hour = 60 minutes
- 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Global Warming Potential

- CO2 1
- CH4 21
- N2O 310

Groundwater Substitution GHG Emissions

Agency Pelger Mutual Water Company
Transfer Volume 4,000 acre feet/year
Location Sutter County

Table 11. Pelger Mutual Water Company GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
Pelger MWC Well 3 Klein	Well 3 Klein	Electric		110	4,300	45%	1,811	2,287	187,712	n/a	33	0.002	0.001	33	0.05	0.16	34
Pelger MWC Well 1 Tucker	Well 1 Tucker	Electric		110	3,100	33%	1,305	2,287	187,712	n/a	33	0.002	0.001	33	0.05	0.16	34
Pelger MWC Well 2 Flopet	Well 2 Flopet	Diesel	2008	173	2,100	22%	884	2,287	n/a	22,193	227	0.009	0.002	227	0.19	0.57	227
				Total	9,500	100%	4,000	6,860	375,424	22,193	293	0.014	0.003	293	0.30	0.90	295

Legend

Pump rate based on Well Development & Test Report (October 13, 1993); maximum test pump rate.
Fuel type assumed to be diesel (worst-case emissions)

Conversion Factors

1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential

CO2 1
CH4 21
N2O 310

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Groundwater Substitution GHG Emissions

Agency Pleasant Grove-Verona Mutual Water Company
Transfer Volume 15,000 acre feet/year
Location Sutter County

Table 12. Pleasant Grove-Verona Mutual Water Company GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
PGVMWC Well #1	Well #1	Electric		30	2,000	3%	394	1,070	23,966	n/a	4	0.0003	0.0001	4	0.01	0.02	4
PGVMWC Well #2	Well #2	Electric		250	5,000	7%	986	1,070	199,715	n/a	36	0.0026	0.0006	36	0.06	0.17	36
PGVMWC Monster Pump	Monster Pump	Electric		60	3,100	4%	611	1,070	47,931	n/a	9	0.0006	0.0001	9	0.01	0.04	9
PGVMWC Well #12&17	Well #12&17	Electric		50	1,500	2%	296	1,070	39,943	n/a	7	0.0005	0.0001	7	0.01	0.03	7
PGVMWC Well #11	Well #11	Diesel	2004	250	4,200	6%	828	1,070	n/a	15,014	153	0.0062	0.0012	153	0.13	0.39	154
PGVMWC Well #13&15	Well #13&15	Electric		240	4,800	6%	946	1,070	191,726	n/a	34	0.0025	0.0005	34	0.05	0.17	34
PGVMWC Well #16	Well #16	Electric		240	1,700	2%	335	1,070	191,726	n/a	34	0.0025	0.0005	34	0.05	0.17	34
PGVMWC Willey #1	Willey #1	Diesel	2000	168	3,000	4%	591	1,070	n/a	10,089	103	0.0042	0.0008	103	0.09	0.26	103
PGVMWC Willey #2	Willey #2	Electric		159	3,000	4%	591	1,070	127,018	n/a	23	0.0017	0.0004	23	0.04	0.11	23
PGVMWC Willey #3	Willey #3	Electric		58	2,000	3%	394	1,070	46,334	n/a	8	0.0006	0.0001	8	0.01	0.04	8
PGVMWC Willey #4	Willey #4	Diesel	1974	150	3,000	4%	591	1,070	n/a	9,008	92	0.0037	0.0007	92	0.08	0.23	92
PGVMWC Well #30	Well #30	Diesel	2000	100	1,500	2%	296	1,070	n/a	6,005	61	0.0025	0.0005	61	0.05	0.15	62
PGVMWC Well #31	Well #31	Electric		99	2,500	3%	493	1,070	79,087	n/a	14	0.0010	0.0002	14	0.02	0.07	14
PGVMWC Well #32	Well #32	Electric		99	2,500	3%	493	1,070	79,087	n/a	14	0.0010	0.0002	14	0.02	0.07	14
PGVMWC Well #33	Well #33	Electric		99	2,500	3%	493	1,070	79,087	n/a	14	0.0010	0.0002	14	0.02	0.07	14
PGVMWC Nicholas Sand Field Well	Nicholas Sand Field Well	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Nicholas Filipino Camp #2	Nicholas Filipino Camp #2	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Nicholas Filipino Camp South	Nicholas Filipino Camp South	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Nicholas Johnston Field Well #2	Nicholas Johnston Field Well #2	Electric		58	2,000	3%	394	1,070	46,334	n/a	8	0.0006	0.0001	8	0.01	0.04	8
PGVMWC Nicholas Johnston Well	Nicholas Johnston Well	Electric		58	2,000	3%	394	1,070	46,334	n/a	8	0.0006	0.0001	8	0.01	0.04	8
PGVMWC Nicholas 72-Acre Field South	Nicholas 72-Acre Field South	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Nicholas 72-Acre Field North	Nicholas 72-Acre Field North	Electric		58	2,000	3%	394	1,070	46,334	n/a	8	0.0006	0.0001	8	0.01	0.04	8
PGVMWC Nicholas BBC Well	Nicholas BBC Well	Electric		58	2,000	3%	394	1,070	46,334	n/a	8	0.0006	0.0001	8	0.01	0.04	8
PGVMWC Kelly 190 Field Well #2	Kelly 190 Field Well #2	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Kelly Windmill Field Well #2	Kelly Windmill Field Well #2	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Kelly Windmill North Field Well	Kelly Windmill North Field Well	Diesel	2002	62	2,000	3%	394	1,070	n/a	3,729	38	0.0015	0.0003	38	0.03	0.10	38
PGVMWC Kelly 306 Well	Kelly 306 Well	Electric		111	2,600	3%	512	1,070	88,673	n/a	16	0.0012	0.0002	16	0.02	0.08	16
PGVMWC Scheidel & Osterli #16	Scheidel & Osterli #16	Diesel	1997	234	3,400	4%	670	1,070	n/a	14,053	143	0.0058	0.0012	143	0.12	0.36	144
PGVMWC Scheidel & Osterli #17	Scheidel & Osterli #17	Diesel	1999	101	1,500	2%	296	1,070	n/a	6,065	62	0.0025	0.0005	62	0.05	0.16	62
PGVMWC Scheidel & Osterli #18A	Scheidel & Osterli #18A	Diesel	1999	101	1,800	2%	355	1,070	n/a	6,065	62	0.0025	0.0005	62	0.05	0.16	62
PGVMWC River Ranch #19	River Ranch #19	Diesel	2008	99	2,500	3%	493	1,070	n/a	5,945	61	0.0025	0.0005	61	0.05	0.15	61
					Total	100%	15,000	33,185	1,379,628	98,351	1,250	0.0588	0.0120	1,250	1.24	3.72	1,255

Legend
Average HP estimated from pump rates
HP interpolated from other pumps

Conversion Factors
1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption
0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential
CO2 1
CH4 21
N2O 310

Groundwater Substitution GHG Emissions

Agency Princeton-Codora-Glenn Irrigation District
 Transfer Volume 5,000 acre feet/year
 Location Glenn County
 Colusa County

Table 13. Princeton-Codora-Glenn Irrigation District GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (AF/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
C MICHAEL	C MICHAEL	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
CHRISMAN 1	CHRISMAN 1	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
CHRISMAN 2	CHRISMAN 2	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
D PEREZ	D PEREZ	D	0	160	5,000	13%	667	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
D PEREZ	D PEREZ	D	0	160	5,000	13%	667	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
R PEREZ	R PEREZ	E	0	110	4,000	11%	533	724	59,442	n/a	11	0.0008	0.0002	11	0.02	0.05	11
WELLER	WELLER	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
G GIESBREST	G GIESBREST	E	0	110	3,000	8%	400	724	59,442	n/a	11	0.0008	0.0002	11	0.02	0.05	11
L HANSEN	L HANSEN	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
J MANN	J MANN	D	0	160	2,500	7%	333	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
B GIESBRECHT	B GIESBRECHT	D	0	160	3,000	8%	400	724	n/a	6,500	66	0.0027	0.0005	66	0.06	0.17	67
				Total	37,500	100%	5,000	7,965	118,884	58,498	618	0.0258	0.0052	618	0.54	1.60	621

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
 0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Provident Irrigation District
Transfer Volume 5,000 acre feet/year
Location Glenn County
Colusa County

Table 14. Provident Irrigation District GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (AF/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
WELLER#4	WELLER#4	E	0	110	3,200	9%	456	774	63,507	n/a	11	0.0008	0.0002	11	0.02	0.06	11
WELLER#1	WELLER#1	D	0	160	3,300	9%	470	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
B WELLER	B WELLER	D	0	160	3,100	9%	442	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
PEREZ&PEREZ	PEREZ&PEREZ	D	0	160	3,200	9%	456	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
A PEREZ	A PEREZ	D	0	160	3,000	9%	427	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
R HANSEN	R HANSEN	D	0	160	3,000	9%	427	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
C MICHAEL	C MICHAEL	D	0	160	2,800	8%	399	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
K HANSEN	K HANSEN	E	0	110	3,000	9%	427	774	63,507	n/a	11	0.0008	0.0002	11	0.02	0.06	11
NAVARRO#1	NAVARRO#1	D	0	160	2,500	7%	356	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
NAVARRO#2	NAVARRO#2	D	0	160	2,000	6%	285	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
D KENNEDY	D KENNEDY	E	0	110	3,000	9%	427	774	63,507	n/a	11	0.0008	0.0002	11	0.02	0.06	11
J MANN	J MANN	D	0	160	3,000	9%	427	774	n/a	6,944	71	0.0029	0.0006	71	0.06	0.18	71
				Total	35,100	100%	5,000	9,284	190,520	62,498	672	0.0284	0.0057	672	0.60	1.77	674

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
 0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Reclamation District 108
Transfer Volume 14,400 acre feet/year
Location Colusa County
Yolo County

Table 15. Reclamation District 108 GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
RD-108 Well 1	Well 1	Electric		100	3,300	18%	2,625	4,321	322,439	n/a	57	0.004	0.001	57	0.09	0.28	58
RD-108 Well 5	Well 5	Electric		150	1,500	8%	1,193	4,321	483,658	n/a	86	0.006	0.001	86	0.13	0.42	87
RD-108 Well 6	Well 6	Electric		250	5,700	31%	4,535	4,321	806,096	n/a	144	0.011	0.002	144	0.22	0.70	145
RD-108 Well 7	Well 7	Electric		250	3,800	21%	3,023	4,321	806,096	n/a	144	0.011	0.002	144	0.22	0.70	145
RD-108 Well 8	Well 8	Electric		250	3,800	21%	3,023	4,321	806,096	n/a	144	0.011	0.002	144	0.22	0.70	145
				Total	18,100	100%	14,400	21,603	3,224,385	0	575	0.042	0.009	575	0.89	2.80	578

Conversion Factors

1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential

CO2 1
CH4 21
N2O 310

2014 Tehama-Colusa Canal Authority Water Transfers
Environmental Assessment/Initial Study

Groundwater Substitution GHG Emissions

Agency Reclamation District 1004
Transfer Volume 5,400 acre feet/year
Location Colusa County
Glenn County
Sutter County

Table 16. Reclamation District 1004 GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
RD-1004Behring Ranch Club House No. 496461	Behring Ranch Club House No. 496461	Electric		202	3,400	6%	330	527	79,512	n/a	14	0.0010	0.0002	14	0.02	0.07	14
RD-1004Behring Ranch Nursery Well No. 17N1W10H1	Behring Ranch Nursery Well No. 17N1W10H1	Diesel	TBD	40	1,000	2%	97	527	n/a	1,184	12	0.0005	0.0001	12	0.01	0.03	12
RD-1004Gardener No. 498178	Gardener No. 498178	Diesel	2009	215	3,500	6%	340	527	n/a	6,362	65	0.0026	0.0005	65	0.06	0.16	65
RD-1004Drumheller Well #7	Drumheller Well #7	Diesel	TBD	162	4,000	7%	388	527	n/a	4,794	49	0.0020	0.0004	49	0.04	0.12	49
RD-1004Myers Well #2 No. 340884	Myers Well #2 No. 340884	Electric	1982	100	4,100	7%	398	527	39,362	n/a	7	0.0005	0.0001	7	0.01	0.03	7
RD-1004Stonewell #6 No. 11334	Stonewell #6 No. 11334	Electric	2006	40	1,800	3%	175	527	15,745	n/a	3	0.0002	0.0000	3	0.00	0.01	3
RD-1004Myers Well #1 No. 3457	Myers Well #1 No. 3457	Electric	2006	40	2,200	4%	214	527	15,745	n/a	3	0.0002	0.0000	3	0.00	0.01	3
RD-1004Hall Well No. 369428	Hall Well No. 369428	Electric	2011	125	4,500	8%	437	527	49,203	n/a	9	0.0006	0.0001	9	0.01	0.04	9
RD-1004Hall Well No. X	Hall Well No. X	Electric	TBD	148	4,500	8%	437	527	58,256	n/a	10	0.0008	0.0002	10	0.02	0.05	10
RD-1004Gardener No. 374672	Gardener No. 374672	Diesel	2008	215	3,500	6%	340	527	n/a	6,362	65	0.0026	0.0005	65	0.06	0.16	65
RD-1004Behring Ranch West Well No. 97863	Behring Ranch West Well No. 97863	Electric		53	2,300	4%	223	527	20,862	n/a	4	0.0003	0.0001	4	0.01	0.02	4
RD-1004Behring Ranch 10 Field Well No. 496441	Behring Ranch 10 Field Well No. 496441	Diesel	2008	225	5,800	10%	563	527	n/a	6,658	68	0.0028	0.0006	68	0.06	0.17	68
RD-1004Behring Ranch Pearl 20094	Behring Ranch Pearl 20094	Diesel	TBD	80	2,500	4%	243	527	n/a	2,367	24	0.0010	0.0002	24	0.02	0.06	24
RD-1004Sikes & Parachini #2 No. 374682	Sikes & Parachini #2 No. 374682	Diesel	2008	150	4,000	7%	388	527	n/a	4,439	45	0.0018	0.0004	45	0.04	0.11	45
RD-1004Sikes & Parachini #1 No. 93124	Sikes & Parachini #1 No. 93124	Diesel	2006	173	4,000	7%	388	527	n/a	5,119	52	0.0021	0.0004	52	0.04	0.13	52
RD-1004Rancho Valeta No. 726883	Rancho Valeta No. 726883	Diesel	2004	170	4,500	8%	437	527	n/a	5,030	51	0.0021	0.0004	51	0.04	0.13	52
				Total	100%		5,400	8,439	278,686	42,315	482	0.0212	0.0043	482	0.44	1.33	483

Legend

	Average HP estimated from pump rates
	HP interpolated from other pumps
	Power rating equal to pump with closest equivalent pump rate

Conversion Factors

1 lb =	453.6 g
1 tonne =	1,000 kg
1 tonne =	1,000,000 g
1 MWh =	1,000 kWh
1 GWh =	1,000,000 kWh
1 kW =	1.34 hp
1 hour =	60 minutes
1 acre-foot =	325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr	(Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL	(Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal	

Global Warming Potential

CO2	1
CH4	21
N2O	310

Groundwater Substitution GHG Emissions

Agency River Garden Farms
Transfer Volume 6,000 acre feet/year
Location Yolo County

Table 17. River Garden Farms GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation			Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)	(tonnes per year)			(MTCO2e per year)					
										CO2		CH4	N2O	CO2	CH4	N2O	Total	
RG Field 65 PW	Field 65 PW	Electric	2008	110	2,500	14%	862	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 71 PW	Field 71 PW	Electric	2001	110	1,700	10%	586	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 98 PW	Field 98 PW	Electric	1963	110	2,900	17%	1,000	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 104 PW	Field 104 PW	Electric	2008	110	2,500	14%	862	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 104-09 PW	Field 104-09 PW	Electric	2009	110	2,990	17%	1,031	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 91-09 PW	Field 91-09 PW	Electric	2009	110	2,840	16%	980	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
RG Field 117 PW	Field 117 PW	Electric	2009	110	1,965	11%	678	1,873	153,774	n/a	27	0.002	0.000	27	0.04	0.13	28	
					Total	100%	6,000	13,113	1,076,417	0	192	0.014	0.003	192	0.30	0.93	193	

Legend

 Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
7.13 lb/gal

Global Warming Potential

CO2 1
CH4 21
N2O 310

Groundwater Substitution GHG Emissions

Agency Roberts Ditch Irrigation Company
Transfer Volume 3,330 acre feet/year
Location Colusa County

Table 18. Roberts Ditch Irrigation Company GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
RDIC Well North	RDIC Well North	E	0	110	4,500	50%	1,665	2,009	164,952	n/a	29	0.0022	0.0005	29	0.05	0.14	30
RDIC Well South	RDIC Well South	E	0	110	4,500	50%	1,665	2,009	164,952	n/a	29	0.0022	0.0005	29	0.05	0.14	30
				Total	9,000	100%	3,330	4,019	329,904	0	59	0.0043	0.0009	59	0.09	0.29	59

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr *(Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)*
 0.855 g/mL *(Based on MSDS for Hess Diesel Fuel All Types)*
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Sycamore Mutual Water Company
Transfer Volume 8,000 acre feet/year
Location Colusa County

Table 19. Sycamore Mutual Water Company GHG Emissions

Sycamore Family Trust1 Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
Sycamore Family Trust11	11	Electric		100	2,500	7%	571	1,241	92,637	n/a	17	0.001	0.000	17	0.03	0.08	17
Sycamore Family Trust15	15	Electric		75	2,500	7%	571	1,241	69,478	n/a	12	0.001	0.000	12	0.02	0.06	12
Sycamore Family Trust14	14	Electric		100	2,500	7%	571	1,241	92,637	n/a	17	0.001	0.000	17	0.03	0.08	17
Sycamore Family Trust17	17	Electric		125	3,500	10%	800	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust1	1	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust2	2	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust3	3	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust4	4	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust5	5	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust6	6	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust7	7	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
Sycamore Family Trust8	8	Electric		125	3,000	9%	686	1,241	115,796	n/a	21	0.002	0.000	21	0.03	0.10	21
					Total	100%	8,000	14,896	1,296,919	0	231	0.017	0.004	231	0.36	1.13	233

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency T&P Farms
Transfer Volume 840 acre feet/year
Location Colusa County

Table 20. T&P Farms GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation (hours/year)	(kWh/yr)	Fuel Consumption (gal/yr)	GHG Emissions						
					(% of Total)	(tonnes per year)					(MTCO2e per year)						
											CO2	CH4	N2O	Total			
NW-3	NW-3	E	0	110	3,500	50%	420	652	53,498	n/a	10	0.0007	0.0001	10	0.01	0.05	10
NW-4	NW-4	E	0	110	3,500	50%	420	652	53,498	n/a	10	0.0007	0.0001	10	0.01	0.05	10
				Total	7,000	100%	840	1,303	106,996	0	19	0.0014	0.0003	19	0.03	0.09	19

Legend

Horsepower estimated based on average size engine for fuel type in study area

Conversion Factors

1 lb = 453.6 g
 1 tonne = 1,000 kg
 1 tonne = 1,000,000 g
 1 MWh = 1,000 kWh
 1 GWh = 1,000,000 kWh
 1 kW = 1.34 hp
 1 hour = 60 minutes
 1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Diesel Engine Fuel Consumption

0.4 lb/hp-hr (Based on spec sheet for John Deere 6068H, 6.8L Engine, 173 HP)
 0.855 g/mL (Based on MSDS for Hess Diesel Fuel All Types)
 7.13 lb/gal

Global Warming Potential

CO2 1
 CH4 21
 N2O 310

Groundwater Substitution GHG Emissions

Agency Te Velde Revocable Family Trust
Transfer Volume 2,925 acre feet/year
Location Yolo County

Table 21. Te Velde Revocable Family Trust GHG Emissions

Description	Well	Fuel Type	Model Year	Power Rating (hp)	Pump Rate		Transfer Volume (acre feet/year)	Operation		Fuel Consumption (gal/yr)	GHG Emissions						
					(gpm)	(% of Total)		(hours/year)	(kWh/yr)		(tonnes per year)			(MTCO2e per year)			
											CO2	CH4	N2O	CO2	CH4	N2O	Total
Sacramento River Ranch123448	123448	elec		127	4656	35%	1,016	1,185	112,320	n/a	20	0.001	0.000	20	0.03	0.10	20
Sacramento River Ranch123447	123447	elec		104	2200	16%	480	1,185	91,979	n/a	16	0.001	0.000	16	0.03	0.08	16
Sacramento River Ranch33839	33839	elec		143	2833	21%	618	1,185	126,471	n/a	23	0.002	0.000	23	0.03	0.11	23
Sacramento River Ranch33838	33838	elec		125	3715	28%	811	1,185	110,551	n/a	20	0.001	0.000	20	0.03	0.10	20
					Total	100%	2,925	4,740	441,321	0	79	0.006	0.001	79	0.12	0.38	79

Conversion Factors

1 lb = 453.6 g
1 tonne = 1,000 kg
1 tonne = 1,000,000 g
1 MWh = 1,000 kWh
1 GWh = 1,000,000 kWh
1 kW = 1.34 hp
1 hour = 60 minutes
1 acre-foot = 325,851 gallons

http://www.water.ca.gov/pubs/dwrnews/california_water_facts_card/waterfactscard.pdf

Global Warming Potential

CO2 1
CH4 21
N2O 310

Engine Size Summary

Table 22

Engine Power Rating Summary by Fuel Type

Fuel Type	No. Engines	Avg. HP	Max HP	Min HP
Diesel	32	160	350	62.1
Electric	53	110	300	15
Natural Gas	1	190	190	190

GHG Emission Factors

Table 23
GHG Emission Factors for Electric Pumps

County	Utility Company	Emission Factors		
		CO2 (lbs/MWh)	CH4 (lbs/GWh)	N2O (lbs/GWh)
Colusa	Pacific Gas & Electric	392.87	28.94	6.17
Glenn	Pacific Gas & Electric	392.87	28.94	6.17
Merced	Pacific Gas & Electric	392.87	28.94	6.17
Placer	Pacific Gas & Electric	392.87	28.94	6.17
Sacramento	Sacramento Municipal Utility District	429.29	28.94	6.17
San Joaquin	Pacific Gas & Electric	392.87	28.94	6.17
Shasta	Pacific Gas & Electric	392.87	28.94	6.17
Solano	Pacific Gas & Electric	392.87	28.94	6.17
Sutter	Pacific Gas & Electric	392.87	28.94	6.17
Yolo	Pacific Gas & Electric	392.87	28.94	6.17
Yuba	Pacific Gas & Electric	392.87	28.94	6.17

Table 24
Utility-Specific CO2 Emission Factors

2009 Emission Rates		
Utility	Factor Type	Emission Factor (lbs CO ₂ /MWh)
Modesto Irrigation District	Retail Power	1,036.17
	Special Power	0
	Wholesale Power	2,048.09
Pacific Gas & Electric	System Average	575.38
Bonneville Power Authority	System Average	93.17
2010 Emission Rates		
Utility	Factor Type	Emission Factor (lbs CO ₂ /MWh)
Sacramento Municipal Utility District	Retail Power	526.47
	Special Power	0.00
	Wholesale Power	828.58
Newmont Nevada Energy Investment	Wholesale Power	2,055.79
Pacific Gas & Electric	System Average	444.64
City of Vernon, Light and Power	System Average	775.83
Modesto Irrigation District	Retail Power	942.99
	Special Power	0.00
	Wholesale Power	2,026.12
Northern States Power Company (Xcel Energy)	System Average	1,047.20
Public Service Company of Colorado (Xcel Energy)	System Average	1,675.51
Southwestern Public Service Company (Xcel Energy)	System Average	1,552.05
Seattle City Light	Retail Power	45.57
	Special Power	0.00
	Wholesale Power	537.64
Bonneville Power Authority	System Average	134.70

2011 Emission Rates		
Utility	Factor Type	Emission Factor (lbs CO ₂ /MWh)
Pacific Gas & Electric	System Average	392.87
Bonneville Power Authority	System Average	47.86
Seattle City Light	Retail Power	13.77
	Special Power	0.00
	Wholesale Power	218.75
Sacramento Municipal Utility District	Retail Power	429.29
	Special Power	0.00
	Wholesale Power	795.14
City of Vernon, Light and Power	System Average	731.49
Northern States Power Company (Xcel Energy)	System Average	1,071.45
Public Service Company of Colorado (Xcel Energy)	System Average	1,618.19
Southwestern Public Service Company (Xcel Energy)	System Average	1,472.69
2012 Emission Rates		
Utility	Factor Type	Emission Factor (lbs CO ₂ /MWh)
City of Vernon, Light and Power	System Average	765.97

Source:

The Climate Registry. 2013. Utility-Specific Emission Factors. Accessed on: January 2, 2014. Available at: <http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/>.

Table 25
eGRID GHG Emission Factors

eGRID 2012 Subregion	eGRID 2012 Subregion Name	2009 Emission Rates		
		(lbs CO ₂ /MWh)	(lbs CH ₄ /GWh)	(lbs N ₂ O/GWh)
AKGD	ASCC Alaska Grid	1,280.86	27.74	7.69
AKMS	ASCC Miscellaneous	521.26	21.78	4.28
AZNM	WECC Southwest	1,191.35	19.13	15.58
CAMX	WECC California	658.68	28.94	6.17
ERCT	ERCOT All	1,181.73	16.7	13.1
FRCC	FRCC All	1,176.61	39.24	13.53
HIMS	HICC Miscellaneous	1,351.66	72.4	13.8
HIOA	HICC Oahu	1,593.35	101.74	21.98
MROE	MRO East	1,591.65	23.98	27.04
MROW	MRO West	1,628.60	28.8	27.79
NEWE	NPCC New England	728.41	75.68	13.86
NWPP	WECC Northwest	819.21	15.29	12.5
NYCW	NPCC NYC/Westchester	610.67	23.75	2.81
NYLI	NPCC Long Island	1,347.99	96.86	12.37
NYUP	NPCC Upstate NY	497.92	15.94	6.77
RFCE	RFC East	947.42	26.84	14.96
RFCM	RFC Michigan	1,659.46	31.41	27.89
RFCW	RFC West	1,520.59	18.12	25.13
RMPA	WECC Rockies	1,824.51	22.25	27.19
SPNO	SPP North	1,815.76	21.01	28.89
SPSO	SPP South	1,599.02	23.25	21.79
SRMV	SERC Mississippi Valley	1,002.41	19.45	10.65
SRMW	SERC Midwest	1,749.75	19.57	28.98
SRSO	SERC South	1,325.68	22.27	20.78
SRTV	SERC Tennessee Valley	1,357.71	17.28	22.09
SRVC	SERC Virginia/Carolina	1,035.87	21.51	17.45
US Territories (not an eGRID Region)*	n/a	1,891.57	75.91	17.13

2014. Available at: <http://www.theclimateregistry.org/downloads/2013/04/2013-Climateregistry-Default-Emissions-Factors.pdf>.

Table 26
Diesel Emission Factors

Pollutant	Emission Factor	Unit	Emission Factor Description
CO2	10.21	kg/gallon	Table 12.1, Distillate Fuel Oil No. 2
CH4	0.003	kg/MMBtu	Table 12.9, Petroleum Products, Industrial
N2O	0.0006	kg/MMBtu	Table 12.9, Petroleum Products, Industrial
Heat Content	0.138	MMBtu/gallon	Table 12.1, Distillate Fuel Oil No. 2

Source: The Climate Registry. 2013. 2013 Climate Registry Default Emission Factors. Accessed on: January 2, 2014. Available at: <http://www.theclimateregistry.org/downloads/2013/04/2013-Climate-Registry-Default-Emissions-Factors.pdf>.

Table 27
Natural Gas Emission Factors

Pollutant	Emission Factor	Unit	Emission Factor Description
CO2	53.02	kg/MMBtu	Table 12.1, US Weighted Average
CH4	0.001	kg/MMBtu	Table 12.9, Natural Gas, Industrial
N2O	0.0001	kg/MMBtu	Table 12.9, Natural Gas, Industrial
Heat Content	1,028	Btu/scf	Table 12.1, US Weighted Average

Source: The Climate Registry. 2013. 2013 Climate Registry Default Emission Factors. Accessed on: January 2, 2014. Available at: <http://www.theclimateregistry.org/downloads/2013/04/2013-Climate-Registry-Default-Emissions-Factors.pdf>.

Table 28. Reduced Exhaust Emissions from Cropland Idling

Water Agency	Groundwater Substitution (acre-feet/year)	Cropland Idling/ Crop Shifting (acre-feet/year)	GW Pumping Equivalent (acre-feet/year)	Annual Emission (MT/year)			Annual Emissions (MTCO2e/year)			
				CO2	CH4	N2O	CO2	CH4	N2O	Total
Biggs-West Gridley Water District	0	32,190	7,574	556	0.03	0.01	556	0.56	1.70	558
Canal Farms	860	635	149	11	0.00	0.00	11	0.01	0.03	11
Conaway Preservation Group	26,639	16,014	3,768	276	0.01	0.00	276	0.28	0.84	278
Glenn-Colusa Irrigation District	26,168	76,000	17,882	1,312	0.06	0.01	1,312	1.33	4.00	1,317
Maxwell Irrigation District	4,700	7,500	1,765	130	0.01	0.00	130	0.13	0.40	130
Pelger Mutual Water Company	4,000	1,903	448	33	0.00	0.00	33	0.03	0.10	33
Pleasant Grove-Verona Mutual Water Company	15,000	9,000	2,118	155	0.01	0.00	155	0.16	0.47	156
Princeton-Codora-Glenn Irrigation District	5,000	3,000	706	52	0.00	0.00	52	0.05	0.16	52
Provident Irrigation District	5,000	3,000	706	52	0.00	0.00	52	0.05	0.16	52
Reclamation District 108	15,000	20,000	4,706	345	0.02	0.00	345	0.35	1.05	347
Reclamation District 1004	5,400	7,500	1,765	130	0.01	0.00	130	0.13	0.40	130
Roberts Ditch Irrigation Company	3,330	2,095	493	36	0.00	0.00	36	0.04	0.11	36
Sycamore Mutual Water Company	8,000	10,000	2,353	173	0.01	0.00	173	0.17	0.53	173
T&P Farms	840	635	149	11	0.00	0.00	11	0.01	0.03	11
Te Velde Revocable Family Trust	2,925	5,387	1,268	93	0.00	0.00	93	0.09	0.28	93
Total	122,862	194,859	45,850	3,364	0.16	0.03	3,364	3.40	10.26	3,378

Notes:

Reclamation District 108 used to estimate emissions for other water agencies.

Engine power rating equal to 140 hp for RD-108 engines.

The Byron Buck memo is based on diesel-fueled engines with sizes ranging from 121 to 225 hp; all engines are noncertified (Tier 0).

RD-108 engines are therefore determined to be a sufficient proxy to estimate the difference in emissions between groundwater substitution and cropland idling.

1 acre-foot of groundwater pumped =

4.25 acre-feet produced by following

Source: Byron Buck & Associates. 2009. "Comparison of Summertime Emission Credits from Land Fallowing Versus Groundwater Pumping."

